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Development of model village cluster for aquaculture: A case in Begunia block of Khordha district, Odisha, India

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Abstract
Jemamantadeipur and Kantabada Villages of Begunia Block, Khordha District, Odisha were adopted in a model village cluster approach in the Department of Biotechnology (DBT), Government of India funded and ICAR-CIFA operated project for demonstration of freshwater aquaculture technologies and livelihood development of the adopted beneficiaries. One fibreglass reinforced plastic (FRP) carp hatchery of 1.0 million seed production per operation in four days capacity was installed and operated in Kantabada Village from 2015 monsoon. Carp brood rearing was done in one 0.2 ha pond and seed rearing practices were undertaken in two ponds of 0.2 ha each at Kantabada and 0.4 ha at Jemamantadeipur. Around 50-60% survival was achieved for each stage of carp seed rearing from spawn to fingerling stage during the demonstration period (2015-2016). One community pond of 2.4 ha with average water spread area (WSA) of 1.4 ha was taken for demonstration of grow out fish culture in Jemamantadeipur Village. Total 76 beneficiary families, mostly tribals from both the villages were adopted in the project. Grow-out carp culture operations were carried out in the community pond of Jemamantadeipur Village in two phases in two years. The first phase was during November, 2015 - June, 2016 and the second phase during September, 2016 - May, 2017. The species cultured were catla, *Catla catla;* rohu, *Labeo rohita;* mrigal, *Cirrhinus mrigala* and grass carp, *Ctenopharyngodon idella* @ 1:2:1:1 ratio and were stocked @ 5,000 fingerlings/ha. The fish production was enhanced from the pre-adoption level of 450 kg/ha/yr to a range of 3,096-3,610 kg/ha/yr. The profit share per beneficiary family of Jemamantadeipur Village was calculated to be Rs. 3,200/= approximately per year from fish culture operations. The present intervention of ICAR-CIFA revealed that the fish production can be increased from the community pond through integrated use of seed, feed and fertilizer resources as inputs. Emphasis was given for improving the knowledge and skills of the farmers for adoption of scientific fish farming practices in their locality for better economic returns.

Keywords: fish production, FRP carp hatchery, model village cluster, aquaculture technology demonstration, livelihood development, tribal farmers

1. Introduction
Odisha State is situated in the eastern part of India, occupies 4.7% of country's landmass and accounts for 3.74 % of India's population. Total SC and ST population constitute about 39.9% of the total state population (www.censusindia.gov.in). About 41.8 % of the total state population depends on daily wages (Census, 2011). Odisha has 80% fish eating population, which means aquaculture will be a profitable culture practice for farmers of Odisha. Availability of quality fish seed, other inputs and knowledge of better management practices (BMP) will help them for aquaculture growth [1-7].

One of the basic premises of rural development is to productively utilize available resources in the local areas. The ponds and tanks available in the villages are often remain unutilized and underutilized due to various reasons like lack of technical knowledge, lack of investment and support of inputs, marketing system, etc. Most of these interventions are to develop aquaculture in one or two ponds involving one or few farmers. In most of the villages, available water resources are owned by the village communities or self help groups or panchayat. These community water resources are controlled and managed by the village communities and the benefits are shared among the community members. The technological demonstrations carried out in these resources are difficult to sustain in absence of the perceived benefits to the members of the communities. Sometimes one or two ponds fail to generate enough benefits to attract members to sustain their effort in aquaculture.

Therefore, to attract the sustained attention of the village communities, it is essential to generate higher level of benefits which can be attained by utilizing all available resources and opportunities in the aquaculture. The utilization of the large water bodies for the grow out culture, small water bodies for seed rearing and farm with brood stock ponds for fish hatchery establishment is a viable strategy in which all the available water bodies of the locality can be utilized. The spawn produced from the hatchery can be reared in the small water bodies and higher sized stocking materials can be stocked in the large water bodies which would generate substantial income and hence, interest among the farmers to adopt aquaculture in their villages. To develop such system, sustained effort need to be undertaken to transfer many aquaculture technologies like hatchery management, seed rearing practices, grow out fish culture, feed preparation, etc to the large number of farmers located within the vicinity. The diverse resources required for development of systems are available in one or few adjacent villages. It is not unusual to find multiple such villages in the coastal areas.

Keeping this in view, several programmes were undertaken in the Department of Biotechnology (DBT), Govt. of India sponsored project "Carp seed production in FRP hatchery and development of integrated rearing system for livelihood development of SC/ST communities in Khordha District of Odisha" operated by ICAR-Central Institute of Freshwater Aquaculture during 2014-17 in four Community Development Blocks namely, Balipatana, Balianta, Banapur and Begunia of Khordha District. The villages Kantabada and Jamamantadeipur of Begunia Block were selected to revitalize the aquaculture development in a model village cluster approach. The present programme was aimed for development of various aspects of aquaculture like quality seed production through establishment of FRP carp hatchery, fish seed rearing, adoption of grow out fish production in scientific manner, single stocking and multiple harvesting of fishes, integration of duck farming with aquaculture, etc. in the village ponds. It was also aimed to evaluate the performance of chain of aquaculture technologies that were transferred to these villages for better utilization of resources for biomass production.

2. Materials and Methods

2.1 Location of the study area

The geographic location of Begunia Block, Khordha District stands at 20º 12´ to 20º 25´ North Latitude and 85º 27´ to 85º 28´ East Longitude. Jemamantadeipur and Kantabada Villages are situated 6 and 4 km away from Begunia Block headquarter respectively.

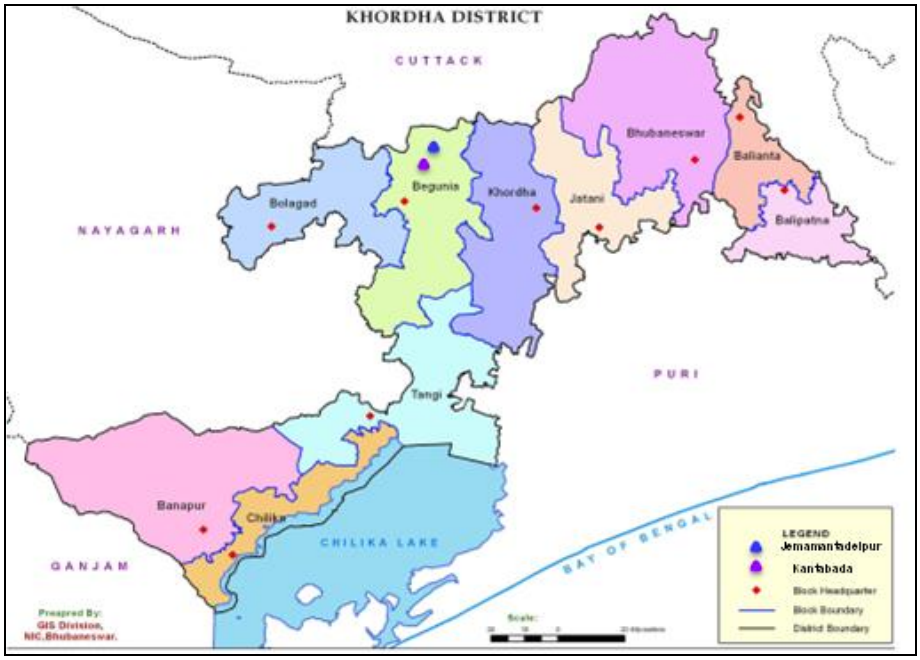

Fig 1: Map of Khordha District, Odisha showing adoption area

2.2 Baseline surveys and adoption of ponds

Before carrying out research work, the scientific team from ICAR-CIFA had gone to the villages for many times to investigate the background socio-economic conditions of the tribal farmers. An assessment was done with a vivid discussion with the people involved in aquaculture directly or indirectly and identified the possible interventions required in the village. Baseline surveys of Jemamantadeipur and Kantabada Villages from aquaculture point of view were carried out using structured questionnaires. Total 61 and 15 beneficiaries from Jemamantadeipur and Kantabada Villages respectively were adopted in the programme. All the beneficiaries from Jemamantadeipur Village are categorized under schedule tribes (ST) and mainly depend on daily wages. Their average annual family income was Rs. 31,300 (10,000 - 56,000) in 2014. The average family size was 4 members; average age of beneficiaries 41.4 years; no education 39 persons; 1-5 class 14 persons and 8-10 class 8 persons. The beneficiaries from Kantabada Village are categorized under schedule tribes (ST) 9 persons, schedule caste (SC) 2 persons and general caste 4 persons. Seven persons are engaged in agriculture, 7 depend on daily wages and 1 does business. Their average annual family income was Rs. 29,775 (14,000 - 1,00,000) in 2014. The average family size was 4 members; average age of beneficiaries 39.3 years; no education 4 persons; 1-5 class 9 persons, 8-10 class 1 person and graduation 1 person.

At Jemamantadeipur Village one community pond of 2.4 ha with water spread area (WSA) of 2.0 ha in rainy season and 0.8 ha during dry season was adopted for grow out fish

culture and one 0.4 ha community seasonal pond was used for seed rearing purpose. For the purpose of calculation of fish production, the WSA of 2.4 ha pond was taken as 1.4 ha (average WSA of rainy and dry season). The scientific composite fish culture practices were adopted in that pond for 6-8 months. The pre-adoption level of fish production from pond was 450 kg/ha/yr. At Kantabada Village 3 ponds of 0.2 ha each were taken for the demonstration programmes. One pond was used as brood stock pond and the rest two were for carp seed rearing purpose.

2.3 FRP carp hatchery installation

The fiberglass reinforced plastic (FRP) carp hatchery was designed and developed by the ICAR-CIFA, Bhubaneswar centre of All India Coordinated Research Project on Plasticulture Engineering and Technology (AICRP on PET) [8, 9]. The FRP carp hatchery is suitable for fish breeding of Indian Major Carps in the field conditions for 20-24 kg of brood fish (female and male in equal proportion) in one operation. It consists of breeding/ spawning pool, hatching/ incubation pool, egg/ spawn collection chamber and overhead storage tank/ water supply system. The product is durable for 12-15 years. It has high abrasion resistance, maintenance free and also easy to operate. Even small and marginal farmers with limited resource can also operate with ease. With the integration of brood stock and seed rearing facilities, the hatchery is able to generate substantial income and profit compared to cost involved in it. The potential of this technology to produce spawn is very high. In one run, about 1.0-1.2 million spawn can be produced.

2.4 Carp brood rearing

Standard carp brood rearing practices were followed by maintaining the stocking density at 1,500-2,000 kg/ha. Mixture of ground nut oil cake (GNOC) and rice-bran at 1:1 (w/w) was used as supplementary feed and the fishes were fed 2-3% of their body weight daily.

2.5 Induced breeding of carps in FRP hatchery

The carps used for breeding trials were reared in the same farm at Kantabada Village. Synthetic hormone (Ovatide) was used as the inducing agent for carp breeding. The dose of Ovatide was 0.5 ml/kg body weight of female and 0.2 ml/kg body weight of male. Standard induced breeding practices for carps were followed in the FRP carp hatchery for seed production [9].

2.6 Carp seed rearing practices

At Kantabada Village two earthen ponds of 0.2 ha each (for spawn to fingerling stage) and at Jemamantadeipur 0.4 ha pond (for fry to fingerling stage) were used as nursery ponds. The water depth was 1.0-1.5 m. The pre-stocking management measures were taken following the standard procedures of carp seed rearing. Phase manuring was done with raw cow dung which was available with the farmers. Five baskets (25 kg) of cow dung were applied to each pond as basal dose, 3 days prior to stocking. After stocking of seed, cow dung was applied based on the availability of plankton population in the nursery pond. Dry feed mixture of ground nut oil cake (GNOC) and rice-bran at 1:1 (w/w) was used as supplementary feed. The dry feed mixture was applied at 400% of initial spawn biomass in the 1st week and doubled in the second week onwards. The daily ration was applied in the pond dividing it to two equal splits during morning and evening. The spawn to fry rearing was done for 15-20 days and then to get fingerlings the rearing of fry was done for 60-90 days. During fry to fingerling rearing the feed was applied @ 10-5% of stocked fish biomass in ponds.

2.7 Grow out culture operation

Grow-out carp culture operations were carried out in the community pond of Jemamantadeipur Village for two times in two years. The first phase was during November, 2015 - June, 2016 and the second phase September, 2016 - May, 2017.

The pond in rainy season with full fill capacity has 2.5 m depth and in dry period 0.5 m. Around 30-40% of the pond area has aquatic weeds and grass, which was controlled manually. The west side bundh of the pond is full of mango trees and the east side has few coconut trees. The outer side of the pond has paddy fields, from where the water used to enter the pond in rainy season. The water samples were collected from the pond and tested for fish firming in every two months interval. Sludge was removed partially from the pond bottom before initiation of grow-out culture of fish and lime was applied @150 kg/ha to maintain the alkaline nature and to rectify the pH of water before stocking of carp seed. Cow dung was applied @ 8-10 t/ha/year in pond at one month interval splitting the yearly dose to months. The inputs like, lime, urea and single super phosphate (SSP) were supplied from the project for application to the pond based on its area and water quality. Those were applied (urea 100-200 kg/ha/yr and SSP 200-400 kg/ha/yr) splitting to every two months interval to the pond during culture period.

The species cultured were catla, *Catla catla;* rohu, *Labeo rohita;* mrigal, *Cirrhinus mrigala* and grass carp, *Ctenopharyngodon idella* @ 1:2:1:1 ratio. The rohu seed was supplied from Kantabada FRP carp hatchery site and other species from the State Government Fish Farm at Kausalyaganga, Puri District, Odisha. The seeds were stocked @ 5,000 fingerlings/ha in November, 2015 in the first phase and harvested in the month of June, 2016. In the second phase the fish seed was stocked in September, 2016 and harvested in May, 2017. Mixture of rice bran and ground nut oil cake (GNOC) at 1:1 ratio was used for feeding the fishes @ 2 % of their biomass. Standard scientific culture practices were followed and 2-3 times partial harvestings was also done to fulfill the needs of the beneficiaries.

2.8 Inputs for duck-cum- fish farming

Two hundred fifty ducklings (21 days old Khaki Campbell), their feed and feeder were supplied on 12 April, 2017 to the beneficiaries of Jemamantadeipur.

2.9 Analysis of physico-chemical parameters of pond water

The physio-chemical properties of pond water such as temperature, transparency, pH, conductivity, total alkalinity and total hardness were analyzed as per standard laboratory procedures (APHA, 2002) [10] in an interval of two months. The plankton volume was measured by filtering 50 liters of water from the pond for productivity analysis.

2.10 Trainings and orientation programmes conducted

ICAR-CIFA had conducted several training and awareness programmes on scientific aquaculture activities to create awareness and skills among the farmers of the area. Those were: Orientation programme on Freshwater aquaculture, 11 June, 2015 held at Kantabada Village and Training

programme on Freshwater aquaculture technologies, 27 September, 2016 held at Jemamantadeipur Village.

3. Results and Discussion

3.1 Creation of awareness among beneficiaries

Other than regular discussions in the villages, two major awareness and orientation programmes were conducted to create interest for scientific aquaculture amongst the farmers of the adopted villages. The main objectives of the programmes were to aware people on fish culture and its benefits; and also to increase fish production and productivity from their ponds; production and adoption of better management practices (BMPs) for enhancement of fish production in a sustainable way. In each time all the village folk participated in these programmes.

3.2 Physico- chemical properties of pond water

Physico-chemical parameters and availability of plankton in the water of adopted ponds were analyzed in every second month during the adoption period. The water parameters of the ponds were ranged for pH 7.3-7.9, conductivity 384-872 m.mho/cm, total alkalinity 60-100 mg/l and total hardness 60-90 mg/l. The ponds were found less productive in terms of plankton volume 0.6-1.4 ml/50 liter water and number of different species were recorded 15 nos (phytoplankton 9 nos. and zooplankton 6 nos.). The plankton species found in the pond waters were; Phytoplankton: Green algae (*Ankistrodesmus*, *Protococcus*, *Microspora*, *Botryoccous*); Diatoms (*Melosira*, *Diatoma*, *Navicula*, *Synedra*, *Frustulia*) and Zooplankton: (*Diaptomous*, *Daphnia*, *Copepods*, *Cladocerans*, *Cyclops*, *Moina*). All the ponds were found suitable for fish rearing with better management practices (BMP) advices [11].

3.3 Carp breeding in FRP hatchery

Carp breeding operations were conducted in the hatchery unit of Kantabada Village during the monsoons of 2015, 2016 and 2017. Total 0.5 and 0.6 million rohu spawn were produced in 2015 and 2016 monsoon respectively. In monsoon of 2017, total 5.5 million rohu and 1.5 million mrigal spawn were harvested from breeding operations. In first two years the farmer was trained for operation of the hatchery in his village and he could breed only rohu. In third year, *i.e.,* 2017 monsoon, he could produce more spawn and could breed two types of carps, *i.e.*, rohu and mrigal.

In field conditions, this ICAR-CIFA model of FRP carp hatchery is being used successfully for production of carp seeds throughout the country. Some published reports are being cited here for comparison of the results. Successful venture of carp seed production in FRP carp hatchery by a farmer at Purunia Village, Patna Block, Keonjhar District, Odisha has been reported [2]. In the first breeding operation he had taken catla (total wt. 7.7 kg) and mrigal (5.8 kg) as trials and 7.5 lakh spawn was produced from the hatchery. With the help of FRP hatchery technology, eight carp breeding programmes were undertaken in Badabishola Village of Mayurbhanj District, Odisha and 56 lakh spawn (47 lakh rohu, 6 lakh grass carp and 3 lakh common carp spawn) could be produced in 2011-2012 [5]. Small scale carp seed production through portable FRP hatchery technology has been transferred to women self help group in a remote and inaccessible village like Khanguri in Nayagarh District, Odisha [6]. The Odisha Watershed Development Mission (OWDM) conducted fish breeding operations in FRP carp hatcheries under the project "Western Odisha Rural Livelihood Project (WORLP)" in Nuapada and Bargarh Districts. In its first year of operation in 2005, the hatchery supported 38 SHGs to nurse 5.5 million fish seeds, which in turn led 153 SHGs to take up growout culture of fish in 530 ha of pond area in Western Odisha [12, 13]. Based on the need assessment, one of FRP hatchery was installed and operated at Puranapradhan Village of Balianta Block, Khordha District, Odisha, India. During breeding season of 2015, the hatchery was used for induce breeding of Indian major carps *i.e.*, rohu (*Labeo rohita*) and mrigal (*Cirrhinus mrigala*) 19 times (*viz.*, rohu 11 times, and mrigal 8 times). Total 198 lakh spawn (carp seed) was produced (*i.e.*, rohu 125 lakh and mrigal 73 lakh) from the breeding operations **[14]**. One unit of FRP carp hatchery was installed and operated at Bali Island, Sunderban, West Bengal during 2014-15**[15]**. During July - August, 2015 for the first time the successful induced breeding of Indian major carps (rohu, *Labeo rohita* and catla, *Catla catla*) and Indian minor carp (bata, *Labeo bata*) was conducted in the established hatchery at Bali and 18.5 lakhs spawn were harvested. FRP carp hatchery was established and operated at Amarpur Village under Potaspur Block, West Bengal in the monsoon of 2016 [16]. Induced breedings of Indian major carps (*Labeo rohita* & *Catla catla*) and Indian minor carp (*L. bata*) were conducted for 4 times in the established hatchery using synthetic hormone "Ovatide". Total 20.5 lakh spawn were harvested, *viz.*, catla 10.0 lakh, rohu 8.0 lakh and bata 2.5 lakh.

3.4 Seed rearing of carps in village condition

In 2015, at Kantabada Village, 3.0 lakh fry (survivability 60.0%) were harvested out of 5.0 lakh spawn from two 0.2 ha each rearing ponds. Out of that 1.6 lakh fry were sold and the rest of 1.4 lakh fry were reared for 60-90 days at Kantabada and Jemamantadeipur Village (0.4 ha pond) for fingerling production. Total 0.9 lakh fingerlings were harvested and out of that 0.8 lakh were sold and the rest 0.1 lakh were stocked in grow out ponds of different villages including Jemamantadeipur for production of table size fishes.

In 2016, in Kantabada Village, 3.0 lakh fry (survivality 50%) were harvested out of 6.0 lakh spawn. Out of that 1.8 lakh fry were sold and the rest 1.2 lakh fry were reared in both village ponds for fingerling production. Total 0.6 lakh fingerlings were produced with survivability of 50%. Out of that 0.45 lakh were sold and the rest were stocked for table fish production in the adopted villages. With experience from the rearing practices in 2015 and 2016, the farmer at Kantabada Village continued the carp seed rearing practices in 2017.

ICAR-CIFA has demonstrated the scientific carp seed rearing practices in different areas of the country. Demonstration of carp seed production and rearing has been done in the farmer's field in a remote village like Badabishola in Mayurbhanj District, Odisha [5]. Approximately 28% fry survivability was recorded after 15 days of rearing of carp spawn in a remote village Khanguri of Nayagarh District, Odisha [6]. Advanced IMC fry (*Catla catla* 17-24 mm & 0.03-0.104 g, *Labeo rohita* 14-18 mm & 0.02-0.037 g, and *Cirrhinus mrigala* 16-22 mm & 0.02-0.051 g) were reared for 40-43 days in different village ponds of Ganjam District, Odisha [17]. In Digapahandi Block the farmers used rice bran and sesame oil cake in the ratio 1:1 as supplementary feed, and in Khallikote and Kukudakhandi Blocks rice bran and ground nut oil cake in the ratio 1:1 was used. Growth of all the three species was better in Digapahandi Block (*C. catla*

57-64 mm & 2.02-2.68 g, *L. rohita* 45-52 mm & 1.67-2.52 g, and *C. mrigala* 36-47 mm & 0.53-0.75 g) than other two blocks. The average survivability achieved in this scientific IMC seed rearing practice from advanced fry to fingerling stage was 65.15%, being highest in Digapahandi Block (70.83%).

3.5 Fish production from grow out culture

In first phase of culture operation the final harvest of fish 1,925 kg (rohu: 800 kg, catla: 400 kg, mrigal: 200 kg and grass carp: 525 kg) was done from the community pond at Jemamantadeipur Village in the month of June, 2016. The culture operation was for 8 months. The average size of harvested fish recorded was rohu 500 g, catla 2.1 kg, mrigal 450 g and grass carp 2.2 kg. From the harvested fish 1,600 kg were sold by the tribal farmers of the village (61 farm families) and 325 kg was consumed by them. Growth of fish from this community pond is given in the Table 1. It was calculated that 1,770 kg of fish was harvested in two partial harvestings. Thus, the total fish production from the pond (WSA of 1.4 ha) was 3,370 kg in 8 months of culture operation. The calculated fish production achieved was 3,610 kg/ha/yr.

In the second phase of operation at Jemamantadeipur Village, the stocking was done in September, 2016 and harvesting in 5 May, 2017. In 8 months of culture period 1,650 kg (rohu: 680 kg, catla: 500 kg, mrigal: 150 kg and grass carp: 320 kg) fish was harvested from the pond. It was calculated that 1,240 kg of fish was harvested in three partial harvestings from the pond as per the need of the villagers. Thus, the total fish production from the pond (WSA of 1.4 ha) was 2,890 kg in 8 months of culture operation. The calculated fish production achieved was 3,096 kg/ha/yr. The growth of the fishes are given in Table 2. The size range of fish recorded was rohu 1.0-1.75 kg (430-500 mm), catla 1.7-2.5 kg (440-510 mm), mrigal 450g-2.1 kg (325-550 mm) and grass carp 1.6-2.5 kg (540-560 mm).

Considering both the year's production, the average calculated fish production achieved was 3,353 kg/ha/yr from the community pond at Jemamantadeipur Village. Originally they got 3,130 kg/1.4 ha WSA of pond/8 months of operation. Pre-adoption fish production was 420 kg/1.4 ha/8 months. The gain they got for adopting scientific aquaculture practices was 2,710 kg/1.4 ha/8 months. The value of the gained fish at farm-gate price of Rs.120/kg was Rs. 3,25,200. For aquaculture operation, the labour and cow dung were given by the beneficiaries of the village. Considering 40% as inputs cost, 60% was the profit and it was calculated to be Rs, 1,95,120 from the fish culture operation. The profit share per beneficiary family of Jemamantadeipur Village (61 tribal families) was calculated to be Rs. 3,200 per year.

Table 1: Growth of fish in first phase of culture operation

Species	Initial stocking		Growth at the time of harvest	
	Length (mm)	Weight (g)	Length (mm)	Weight (g)
C. catla	46-82	3.4-6.6	200-250	1800-2500
L. rohita	42-77	3.1-5.2	185-230	460-750
C. mrigala	40-84	2.7-5.1	140-200	395-568
C. idella	39-54	3.0-6.4	193-296	1760-2670

Table 2: Growth of fish in second phase of culture operation

Species	Initial stocking		Growth at the time of harvest	
	Length (mm)	Weight (g)	Length (mm)	Weight (g)
C. catla	55-95	4.4-8.8	440-510	1700-2500
L. rohita	58-88	4.3-7.2	430-500	1100-1750
C. mrigala	52-93	3.7-5.9	325-550	450-2100
C. idella	48-64	4.0-8.0	540-560	1600-2500

Area saturation model of freshwater aquaculture technology demonstration for livelihood development of tribal farmers of Niladriprasad Gram Panchayat of Banpur Block, Khordha District, Odisha was undertaken by ICAR-CIFA during 2015-2016 [7]. The fish production was enhanced from the baseline of 250 kg/ha/yr to a range of 428.5 – 2,880 kg/ha/yr in all 20 adopted villages of Banpur Block. From 25 ponds, a total of 6,171 kg of fish were harvested during the culture period of 6.5 months and the estimated average fish production was 1,372.6 kg/ha/yr. In the present study the fish production achieved was above 3 t/ha/yr. Livelihood development of the 'Aila' affected 51 tribal families through aquaculture was initiated by ICAR-CIFA in 2011-2012 at Bali Island of the Sunderban, West Bengal. By April, 2014 the average fish production of 4-6 MT/ha/yr from a benchmark of 1.0 MT/ha/year was achieved in the Island [18]. Under a DBT (Govt. of India) funded project, ICAR-CIFA could produce 2,986 kg/ha/yr (1,750-4,667 kg/ha/yr) in SC/ST adopted ponds in Nayagarh District and 2,433.5 kg/ha/yr (1,050-5,075 kg/ha/yr) in Mayurbhanj District of Odisha from the pre-adoption level of 250 and 408 kg/ha/yr respectively **[19]**. A participatory approach was envisaged by KVK (Khordha), Kausalyaganga for mobilizing communities, stocking ponds and adopted all Scientific Management Practices in Khordha District of Odisha. During 2011-13, it demonstrated fish culture in five community ponds covering an area of 6 ha. An average production of 2,241 kg/ha/year was realized against the farmer's practice of 1546 kg/ha/yr [20].

3.6 Integrated aquaculture

Two hundred fifty ducklings (21 days old Khaki Campbell) were supplied on 12 April, 2017 to the beneficiaries of Jemamantadeipur. Integrated farming of duck-cum-fish was being developed in the village. The ecosystem developed in the village helped them to improve co-existing bio-system. The birds grew at an average of 350-400 g/month and matured in 6-7 months. The egg laying capacity is quite excellent with an average of 260-280 eggs in a year. The protein dependency has been reduced to a great extent through eggs at an average of 3 eggs a week to the beneficiaries as well as the meat. The sturdy breed has less mortality and are infection resistant in contrast to other

breeds, thus, reducing the management requirement to minimum. The main advantages of raising Khaki Campbell ducks is 'their meat and eggs are very tasty and have huge demand and price in the market'. Like most other domestic duck breeds, raising Khaki Campbell ducks is also very easy and these ducks are very friendly and are of good temperament.

4. Conclusion

Two adjacent villages Jemamantadeipur and Kantabada of Begunia Block, Khordha District, Odisha were adopted in a model village cluster approach in the DBT, Government of India funded and ICAR-CIFA operated project for demonstration of different freshwater aquaculture technologies such as induced breeding of fishes in fibreglass reinforced plastic (FRP) hatchery, carp brood rearing, seed rearing, grow out fish culture and integrated aquaculture. All these activities were integrated to each other for wholesome development of the village cluster. The average fish production achieved from culture operations from the community pond at Jemamantadeipur Village was 3,353 kg/ha/yr from a baseline of 450 kg/ha/yr. The profit share from fish culture operations per beneficiary family was calculated to be Rs. 3,200/= approximately per year. Integrated duck-cum-fish farming also helped the beneficiaries in terms of nutritional security for them. The installation of FRP hatchery at Kantabada Village will act as the nucleus for quality seed supply for development of aquaculture in the region.

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